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Mars Exploration Rover

MER Surface Lifetime
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Introduction

- **Surface Lifetime defined as the last sol at which energy produced by the MER solar panel, margined by project policy, exceeds energy required for vehicle thermal survival plus 65Whr for science operations.**
  - **E(array) > (1 + margin) * (E (thermal survival)) + 65Whr**
- **Changes since last landing site workshop:**
  - **First thermal characterization test demonstrates insulation capability of WEB thermal design.**
    - **Thermal model (model 'E') updated to incorporate test results and rover configuration changes, particularly heat 'leaks' associated with cabling runs.**
  - **Array vendor selected with string/cell layout against mechanical design of solar panels**
  - **MGS data provided giving revised thermal inertial/albedo measurements at candidate landing sites**

Estimated Surface Lifetime

			Model E Interpolation with 15% Margin + 65Whr	
			MERA	MERB
Hematite				
TM10A2	2.07S, 6.08W		112	
TM20B2	2.07S, 6.08W			100
Gusev				
EP55A2	14.82S, 184.85W		92	
Melas Chasma				
VM53A2	8.88S, 77.48W		100	
VM53B2	8.88S, 77.48W			84
Isidis Planitia				
IP84A2	4.31N, 271.97W		136	
IP96B2	4.31N, 271.97W			124

Issue for Hematite

- Calculation of energy for thermal survival based on candidate landing site environment model used as input to thermal model.
  - Environment model for landing site generated as a 1D model from GCM and uses a '1-sigma' estimate of expected thermal inertia and albedo for the given site.
- Recent MGS data suggest Hematite model was no longer a '1-sigma' estimate. Absence of data coverage across the ellipse cast doubt about statistics derived from data that is available
- Used a '3-sigma' model estimate for Hematite of TI=150 and Albedo=0.15 and prepared another 1D model from GCM.
  - Additional 52Whr for thermal survival required by the end of the mission when temperatures about 7degC colder.
- Estimated lifetime impact at Hematite if TI/Albedo of 150/0.15 is a pixel where MER lands
  - MERA surface lifetime : reduced from 112sols to 92sols
  - MERB surface lifetime : reduced from 100sols to 80sols

Thermal Inertia / Albedo

		Bulk Therm Iner	Albedo
Hematite			
TM20B2	Model Used	240	0.175
	Average MGS Data	222	0.165
	1 Std Dev	19.1	0.02
Gusev			
EP55A2	Model Used	220	0.125
	Average MGS Data	274	0.222
	1 Std Dev	34.7	0.023
Melas Chasma			
VM53B2	Model Used	230	0.18
	Average MGS Data	345	0.153
	1 Std Dev	84.5	0.027
Isidis Planitia			
IP96B2	Model Used	440	0.225
	Average MGS Data	454	0.228
	1 Std Dev	41.5	0.003
Eos Chasma			
VM41A2	Model Used	-	-
	Average MGS Data	386	0.136
	1 Std Dev	56.5	0.011
Athabasca Vallis			
EP49B2	Model Used	-	-
	Average MGS Data	313	0.245
	1 Std Dev	51.4	0.006

Hematite TI vs Albedo

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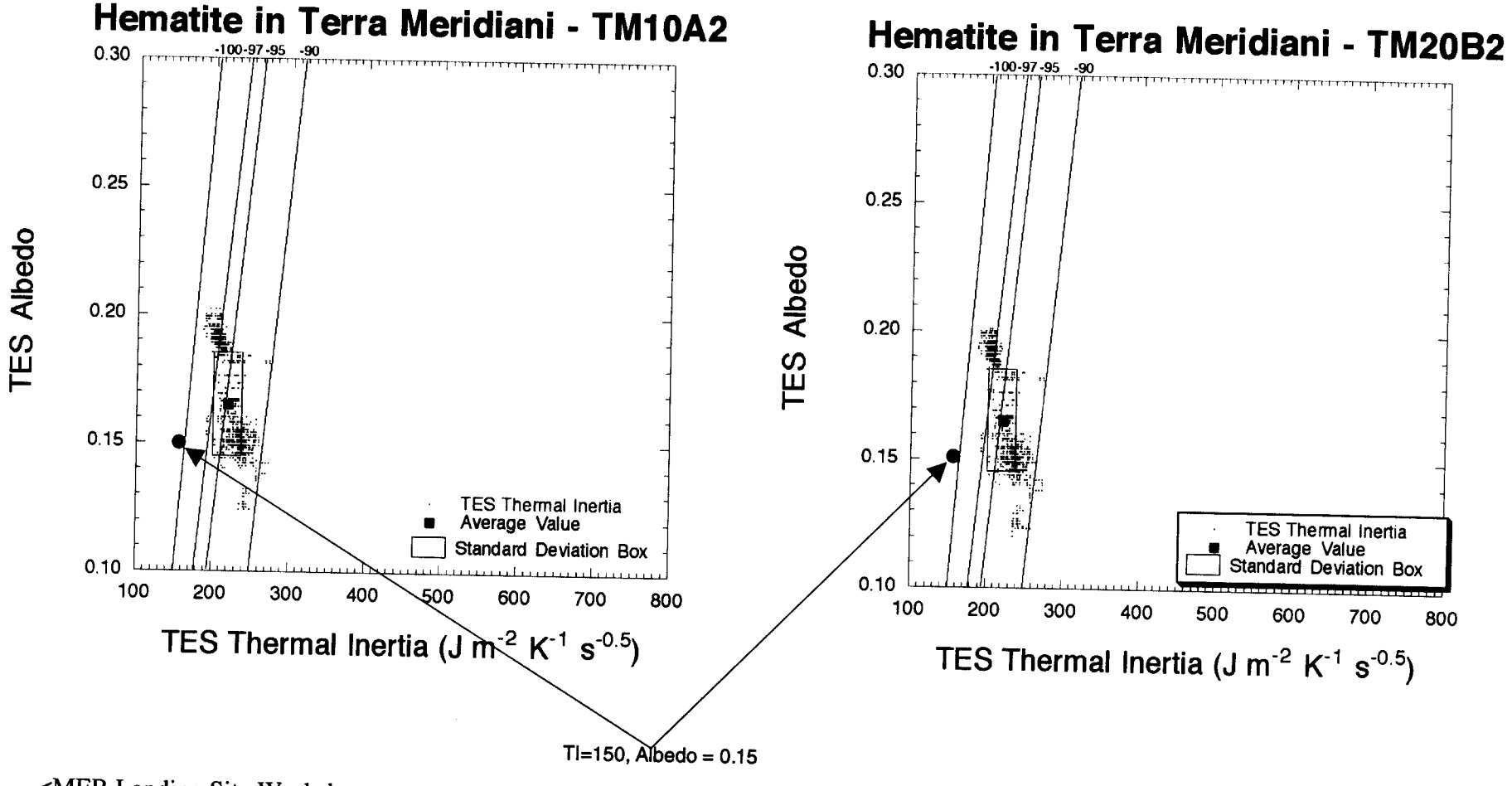

Hematite Landing Sites and Temperatures relative to -97degC

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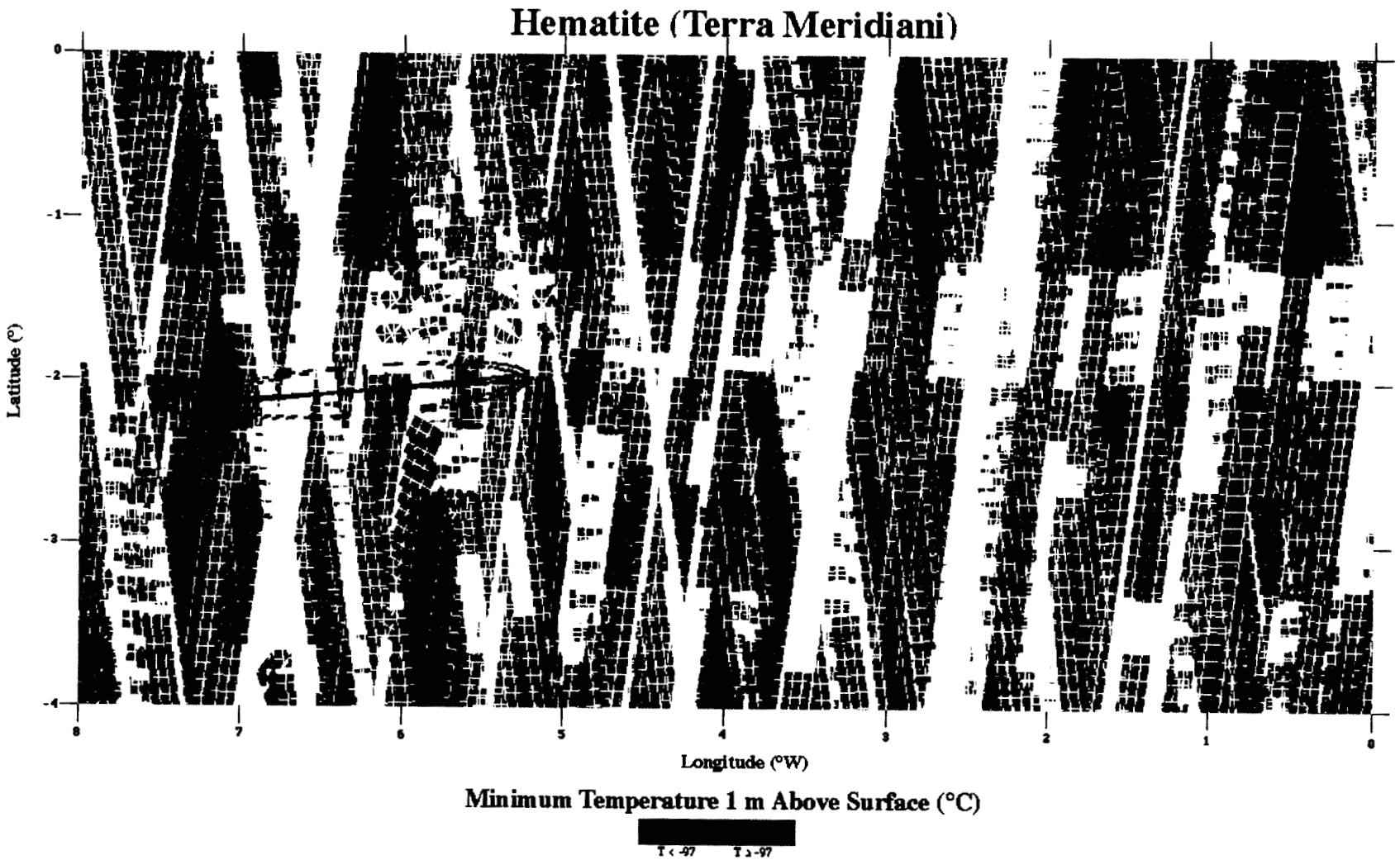

Rover Electronics Module (REM) Heating vs Environment

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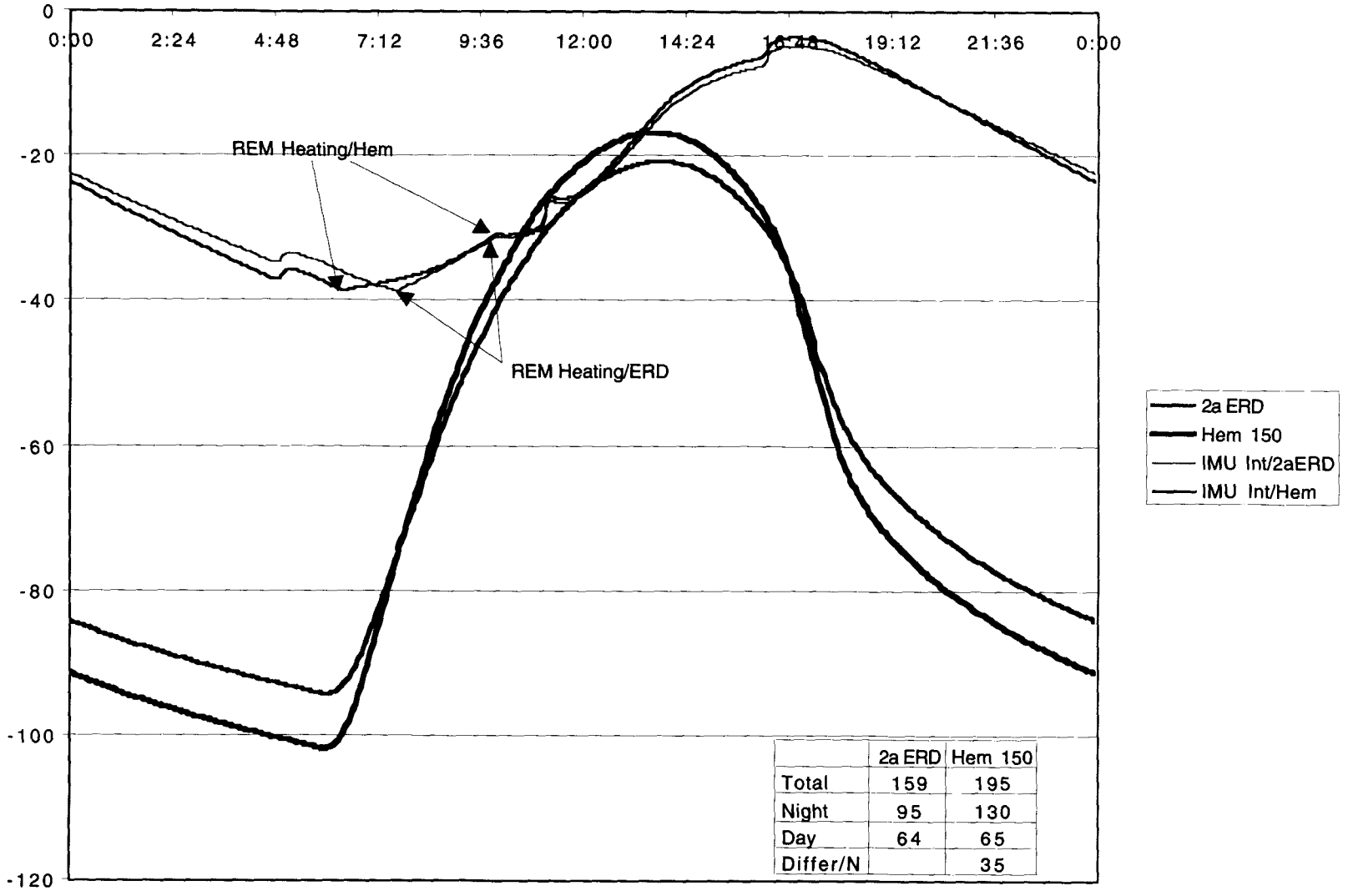

	2a ERD	Hem 150
Total	159	195
Night	95	130
Day	64	65
Differ/N		35

Other Engineering Constraints

- **Total mission energy**
  - **Landing latitude and mission (A/B) determines total energy available for surface activities, communication, and survival lifetime**
    - **10% to 20% more planning energy for MER-A than MER-B at same latitude**
    - **Lifetime increases as you go North (Sun is moving North at this time)**
  - **Mission (A/B) determines energy cost of direct-to-Earth communication as a function of time**
    - **25% to 15% less efficient data return for MER-B compared to MER-A**
    - **70m DSN antenna energy cost of data ranges from 4.5 Whr/Mb to 14 Whr/Mb**
    - **UHF energy cost of data constant at 0.8 Whr/Mb**
    - **UHF volume mediates A/B data return differences**
      - **Typical mission scenarios return 4.7 Gb for MER-A at Gusev, 4.4 Gb for MER-B at Isisdis**
- **Trafficability**
  - **Landing site rock abundance affects rover traverse capability**
  - **High rock abundances would result in shorter planned traverses, overall lower traverse capability**

Total Mission Energy

		Total Planning Energy with 15% Margin for 90sols (kWhr)	
		MERA	MERB
Hematite			
TM10A2	2.07S, 6.08W	22.0	
TM20B2	2.07S, 6.08W		19.2
Gusev			
EP55A2	14.82S, 184.85W	22.0	
Melas Chasma			
VM53A2	8.88S, 77.48W	21.9	
VM53B2	8.88S, 77.48W		17.6
Isidis Planitia			
IP84A2	4.31N, 271.97W	23.8	
IP96B2	4.31N, 271.97W		22.8

Trafficability

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Designation	Site Lat/Long	IRTM Rock Mean	Traffic Fact	IRTM Rock Min/Max	Traffic Fact Min/Max
Hematite					
TM10A2	2.07S, 6.08W	5.5	1.004	1, 8	1, 1.042
TM20B2	2.07S, 6.08W	5	1.002	1, 7	1, 1.01
Gusev					
EP55A2	14.82S, 184.85W	5.8	1.006	3, 8	1, 1.042
Melas Chasma					
VM53A2	8.88S, 77.48W	11.5	1.253	10, 13	1.129, 1.462
VM53B2	8.88S, 77.48W	11.5	1.253	10, 13	1.129, 1.462
Isidis Planitia					
IP84A2	4.31N, 271.97W	14	1.685	9, 17	1.077, 3.8
IP96B2	4.31N, 271.97W	14	1.685	9, 17	1.077, 3.8
Eos Chasma					
VM41A2	13.35S, 41.38W	17	3.8	12, 22	1.311, -
Athabasca Vallis					
EP49B2	8.92N, 205.21W	12.8	1.428	6, 19	1.007, -